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CEREBROSPINAL MENINGITIS AT ANGEL ISLAND IMMIGRATION STATION, CALIF.

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During the year 1920 it became apparent to the medical officer in charge of the Angel Island Immigration Station that an unusual number of cases of epidemic cerebrospinal meningitis was occurring among aliens detained at the station, and a commissioned medical officer was detailed by the Surgeon General of the United States Public Health Service to make an epidemiological study of the disease and to devise measures for its control.

In order to determine whether the disease was on the increase at the station a study of the hospital records since the year 1914 was made. These records showed that 10 cases of meningitis had occurred up to January 1920. Of these 10 cases, only 7 could be properly charged to the station, since the time between the arrival of the vessel and admission of 3 cases to the hospital was of too short an incubation period for the infection in these cases to have been contracted at the immigration station. These three cases became ill from one to four days after leaving the ship. The greatest number of cases occurring in any one year was four, all of them occurring during the month of February, 1914. The next largest number, three cases, occurred in 1919. Table I shows the number of cases of meningitis, the nationality of the patients, the name of the vessel on which they arrived, the date of the arrival of vessel, and the date of admission to hospital.

TABLE I.—*Cases of cerebrospinal meningitis admitted to Immigration Hospital, Angel Island, Calif., during the period Jan. 1, 1914, to Dec. 30, 1919.*

Number.	Nationality of patient.	Name of vessel.	Date vessel arrived.	Date patient was admitted to hospital.
1	Japanese.....	Manchuria.....	Feb. 2, 1914	Feb. 11, 1914
2	Spanish.....	City of Sydney.....	Feb. 14, 1914	Feb. 25, 1914
3	African.....	do.....	do.....	Feb. 24, 1914
4	Spanish.....	do.....	do.....	Feb. 25, 1914
5	Chinese.....	Korea.....	June 21, 1915	June 25, 1915
6	do.....	do.....	June 30, 1918	Sept. 23, 1918
7	do.....	China.....	July 27, 1919	July 27, 1919
8	do.....	do.....	do.....	(¹)
9	Japanese.....	Shinyo Maru.....	Nov. 24, 1919	Nov. 25, 1919
10	Chinese.....	China.....	Dec. 17, 1919	Dec. 30, 1919

¹ To isolation hospital from ship. Admitted to Immigrant Hospital; convalescent Sept. 3, 1919.

Up to October, 1920, four cases had occurred, and in each one of these cases the date between the arrival of vessel and admission of case to hospital was very short, two to four days, showing that the infection was probably contracted aboard ship and not at the station.

TABLE II.—*Cases of cerebrospinal meningitis admitted to immigration hospital, Angel Island, Calif., during period Jan. 1, 1920, to Sept. 30, 1920.*

Num-ber.	Nationality of patient.	Name of vessel.	Date vessel arrived.	Date patient was admitted to hospital.
1	Chinese.....	China.....	Apr. 16, 1920	Apr. 19, 1920
2	do.....	do.....	do.....	do.....
3	do.....	do.....	June 12, 1920	June 16, 1920
4	do.....	Tenyo Maru.....	Sept. 10, 1920	Sept. 12, 1920

From October 27, 1920, to January 20, 1921, 15 cases occurred, which in all probability were contracted at the station, since the time between the arrival of the vessel and the admission of the patient to hospital varied from six days to over one month. Table III gives the information concerning these cases in detailed form.

TABLE III.—*Cases of cerebrospinal meningitis admitted to immigration hospital, Angel Island, Calif., during the period Oct. 27, 1920, to Jan. 20, 1921.*

Num-ber.	Nationality of patient.	Name of vessel.	Date vessel arrived.	Date patient was admitted to hospital.
1	Chinese.....	China.....	Oct. 20, 1920	Oct. 27, 1920
2	do.....	Shinyo Maru.....	Oct. 3, 1920	Nov. 2, 1920
3	do.....	Colombia.....	Nov. 8, 1920	Nov. 19, 1920
4	do.....	Venezuela.....	Dec. 3, 1920	Dec. 9, 1920
5	do.....	Nanking.....	Nov. 27, 1920	Dec. 14, 1920
6	do.....	Tjikembang.....	Nov. 26, 1920	Dec. 13, 1920
7	do.....	Venezuela.....	Dec. 3, 1920	Dec. 17, 1920
8	do.....	Arrest case.....	Dec. 8, 1920	Dec. 22, 1920
9	do.....	Nile.....	Dec. 12, 1920	Dec. 23, 1920
10	do.....	do.....	do.....	Dec. 24, 1920
11	do.....	Nanking.....	Nov. 27, 1920	Dec. 28, 1920
12	do.....	do.....	do.....	Dec. 29, 1920
13	do.....	China.....	Dec. 30, 1920	Jan. 16, 1921
14	do.....	do.....	do.....	Jan. 17, 1921
15	do.....	Shinyo Maru.....	Dec. 21, 1920	Jan. 20, 1921

If we accept the incubation period as being from 5 to 14 days (since authorities are not agreed upon any definite incubation period), then all of these latter cases may have been due to conditions present at the station.

Epidemiological investigations of this disease show that the human carrier is the greatest single factor in the spread of it. Nevertheless, a careful study was undertaken to determine whether other factors might not have some bearing upon its spread. The factors studied were foods, transmission indirectly through unclean dishes and bed linen, meteorological conditions, overcrowding, lowering of

resistance by reason of other illnesses, and the presence of human carriers.

The food served to the detained aliens is of good quality, properly prepared, and served in a cleanly manner. The aliens are served their meals in a large, clean dining room. Each alien is given separate dishes and tableware, and each common bowl or dish has its own spoon or fork for serving portions, so that there is little or no danger of contaminating the common bowl by any individual's spoon or fork. The various groups of orientals and Europeans are served at different times and there is no intermingling among them. The food given the various races differs only in minor essentials. The meals are what are known as oriental and European, the oriental meal being practically the food used in the Orient, and the European meal corresponding to food eaten in this country. A number of orientals avail themselves of the European meal.

In Table III it is noted that only Chinese have been affected. These Chinese were all males, detained in two large rooms, separate from detained aliens of other races and opposite sex. If food be considered a factor, then a proportionate number of cases should have occurred among aliens other than the male Chinese. There were no cases among other groups.

Unclean dishes as a factor can be ruled out for the same reasons as the food. The dishes used were the same for all groups and were washed after being used by each group. The method of washing dishes and tableware is satisfactory and is purely mechanical. It consists of immersing them in boiling soapy water and rinsing in at least two changes of clean hot water, which practically sterilizes them.

Blankets, bed linens, and towels are the property of each individual and are washed by him as often as he desires or as necessity demands. There are no facilities for drying linen or for airing bed clothes. There is apparently no interchange of blankets and linen.

Meteorological conditions have an important indirect bearing on the incidence of the disease. A comparison of the Weather Bureau reports taken for the months of October, November, December, and January for three years shows that for the last three months of 1920 and for January, 1921, the number of rainy and cloudy days was greatly in excess of that of former years, the number of clear days being correspondingly diminished. Table IV shows the temperature, the amount of precipitation, and the number of clear, rainy, and cloudy days for the months of October, November, and December, of 1918, 1919, 1920, and for January, 1919, 1920, and 1921.

TABLE IV.—*Summary of weather conditions.*

Date.	Temperature (° F.).				Precipitation.	Number of days.		
	Mean.	High.	Low.	Normal.		Clear.	Rainy.	Cloudy.
October.....				58.4				
1918.....	64	85	52		0.17	21	5	10
1919.....	60.7	83	48		0.27	22	3	8
1920.....	60.2	78	49		1.83	18	7	13
November.....				55.5				
1918.....	55.6	72	45		5.60	18	9	12
1919.....	56	73	38		0.44	24	2	6
1920.....	56	69	45		2.70	12	10	19
December.....				49.9				
1918.....	50.2	64	38		2.62	18	7	13
1919.....	48.8	62	37		3.21	12	10	19
1920.....	51.1	61	42		7.48	11	16	23
January.....				49.5				
1919.....	51.2	63	37		2.57	19	7	12
1920.....	52.2	70	38		0.26	15	4	16
1921.....	51	61	39		4.67	11	9	13

¹ Up to Jan. 24, 1921.

The temperature was about the same for all years. The precipitation was greater for the last four months of this period. The seasonal precipitation for 1921 up to and including January 24 was more than in normal years. The number of clear days was considerably smaller, the number of cloudy and rainy days being correspondingly larger during the last four months. Because of this condition, the ground remained wet and muddy over a considerable period of time, which prohibited the aliens from going out of doors for days at a time, depriving them of much needed exercise and fresh air. This inability to go outdoors increased the visiting and gambling in the barracks and produced a more prolonged and intimate contact. It is a very common sight to see three or four Chinese perched upon one bunk playing cards or dice or holding conversations. Large groups, crowded closely together, are frequently seen gambling in various parts of the room.

The elimination of food, dishes, bed linen, and weather conditions directly as factors in the outbreak of the disease brings us down to a consideration of overcrowding, lowered resistance, and carriers. It is well known that overcrowding, together with the presence of a virulent carrier or a number of carriers, will spread the disease very rapidly to epidemic proportions, even though there may be no cases in the general population at large.

A study of the records of the San Francisco Board of Health for three years shows an average of 41 cases occurring each year. For the seven months since July, 1920, only 21 cases have occurred, of which number, 16 have been reported to the authorities by the immigration station. This leaves only five cases charged to the city proper with its population of over 500,000. From these records it can be seen that this is not an epidemic year for cerebrospinal meningitis in so far as San Francisco is concerned.

The male Chinese are detained in the two large, main rooms, 75 feet long, 36 feet wide, and 11½ feet high. Each room contains 192 standard steel bunks, in tiers of three high, one directly above the other, and close together, arranged in pairs. There is about 6 feet of space between the top bunk and the ceiling. There are four sets of these bunks, set about 2 feet apart and extending practically the length and width of the room. The bunks are placed in the center of the room; there are no bunks at the side of the room. They are about 6 feet long and 2 feet wide. If the occupant be a tall person, his feet probably touch the head of the sleeper in the next bunk. The space per head in cubic feet is only 158 when all the bunks are occupied. No allowance, however, is made for bunks, tables, benches, projecting surfaces, baggage, parcels, and other objects which diminish the available air space. During part of the months of December and January the available space at the station was still further diminished by having a number of aliens sleep on the floor, all the bunks being occupied. According to Rosenau, the United States immigration law requires 500 cubic feet of space per head in the steerage. The allowable floor space per head as usually stated by authorities is about 42 to 50 square feet. The amount allotted at this station when all bunks are occupied is only about 14 square feet, or about one-third of what the floor and air space should be.

The population records for this station for the year 1920 and for January, 1921, were studied, and an average for each month was made.

TABLE V.—*Population of detained males by months for 1920 and for January, 1921.*

Date.	Male Chinese.	Other males.	Date.	Male Chinese.	Other males.
1920.			1920—Continued.		
January.....	245	34	September.....	226	20
February.....	222	36	October.....	320	22
March.....	130	23	November.....	291	14
April.....	192	34	December.....	395	13
May.....	164	24			
June.....	206	13	1921.		
July.....	253	34	January.....	341	16
August.....	195	33			

It is seen from Table V that the greatest number of male Chinese were detained during the last four months. The males of other races averaged less than 30 per month and were quartered in barracks of sufficient floor and air space, so that overcrowding seldom occurred with them. Figure 1 shows the average number of detained male Chinese by weeks, and it can be seen at a glance that with the exception of one week in June there was practically very little crowding up to September. Beginning with the last week in September, the crowding became greater and continued to increase, with

slight variations, until the first week in January, 1921. From the first week in December to the third week in January, the congestion was at its highest level for a continuous period of six or seven weeks. As shown in Figure 1, there was no continuous crowding prior to the outbreak of the disease which lasted longer than one weekly period. In the last two weeks of October the overcrowding was continuous and was followed by one case of meningitis on the 27th and a second case on November 2. The number of aliens was again increased during the week ended November 13, and a case was reported on the 19th. For two weeks the number of aliens was decreased, but during the first week in December overcrowding again became pronounced.

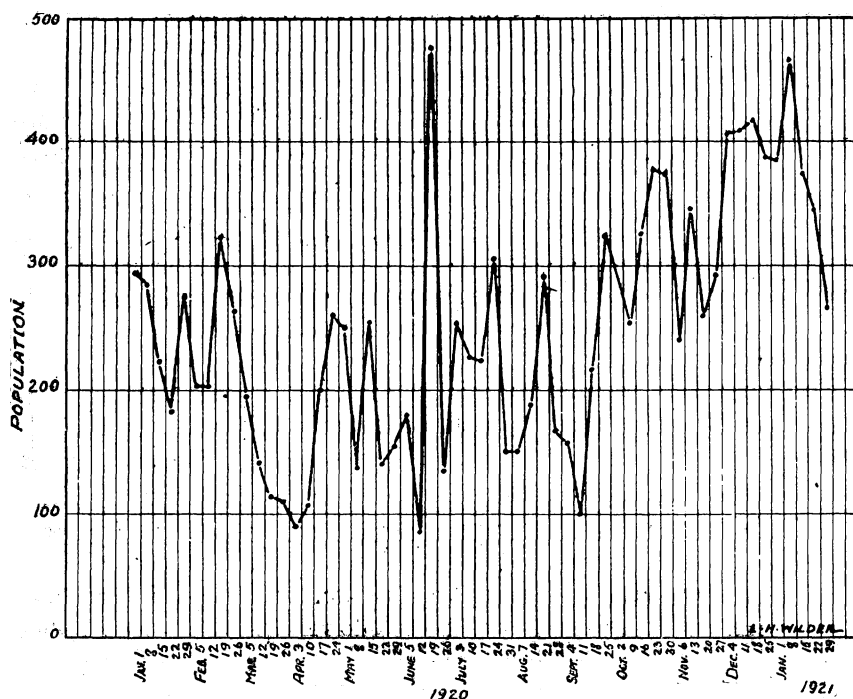


FIG. 1.—Average population of detained male Chinese, by weeks, 1920 and part of 1921.

This period of overcrowding was continuous for five weeks, and nine cases occurred within 20 days. During the last week of December and the first week of January, although the overcrowding was still great, there was slightly less congestion than during the preceding three weeks. The highest peak of overcrowding was reached during the week ended January 8, when 474 aliens were quartered in the barracks. This peak was followed eight or ten days later by three new cases. Up to February 1, 1921, no cases had occurred since January 20. It is a noticeable fact that within a week or ten days following a period of extreme overcrowding, the number of cases of meningitis increased. One or two weeks after the arrival of a large

number of aliens, additional cases occurred. This is shown very clearly in Figure 2, which gives the average number of aliens detained by weeks and the occurrence of cases during these weeks, from the first week of October, 1920, until the last week in January, 1921.

Coupled with this overcrowding was the factor of inclement weather. As previously observed, the number of rainy and cloudy days was greater than for this period in previous years, and the amount of precipitation during this period was much in excess of that for former years. This condition kept the aliens indoors for more prolonged and intimate contact. The ground was wet and muddy and the aliens could not be induced to go out to exercise; they preferred to remain indoors sleeping, visiting, or gambling.

It has been demonstrated by a number of investigators that an outbreak of a communicable disease renders the population more susceptible to the contraction of epidemic cerebrospinal meningitis.

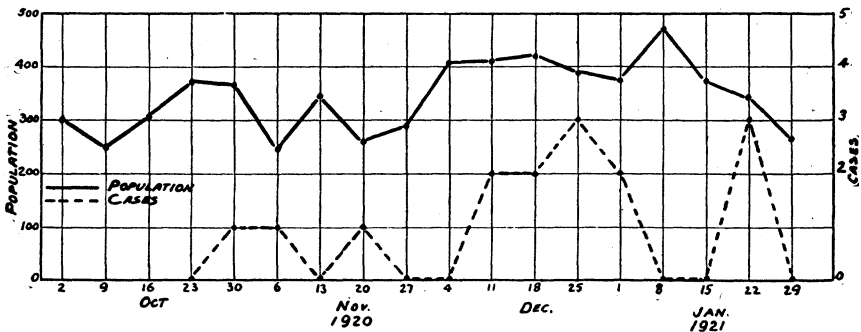


FIG. 2.—Average weekly population of detained male Chinese, and weekly number of cases of meningitis, October 2, 1920, to January 29, 1921.

There was such an outbreak at this station. In July of 1920, five cases of epidemic parotitis occurred, followed by the same number of cases in August. The disease did not flare up again until October, in the latter part of which month 2 new cases were reported, followed by 18 cases in November, 15 cases in December, and 7 cases in January. The same conditions operating to cause the meningitis epidemic probably contributed to the spread of the parotitis. The mumps ceased at about the same time as did the meningitis. It is highly probably that this outbreak of mumps lowered the resistance of the aliens and made them more susceptible to meningitis. Figure 3 shows to some extent how the meningitis cases followed each increase in the mumps.

The last factor to be considered was the human carrier. Having all the previously mentioned factors but no human carrier, it is doubtful whether any cases of meningitis would have occurred. The micro-organism is sensitive to an unsuitable environment and readily succumbs outside of the body. Hence, exceptionally favorable condi-

tions for its immediate transference from person to person are necessary for its propagation. In this instance the favorable conditions were the overcrowding, increased by unfavorable weather and an outbreak of epidemic parotitis. It is also highly probable that a virulent carrier was present with a highly pathogenic type of organism.

It was therefore determined to culture all the detained male Chinese. Altogether, 253 aliens were cultured on January 28, of which number 23, or 9.1 per cent, were shown to be carriers by means of the agglutination test and the differential sugar media. These carriers were isolated in the hospital and a negative release culture was taken a few days later. Since 9.1 per cent of carriers were found among the 253 aliens cultured, it is readily conceivable how great a factor they might be in the spread of the disease. It is not possible to state which carrier or carriers were responsible for the outbreak, as we have no means at present for determining virulence.

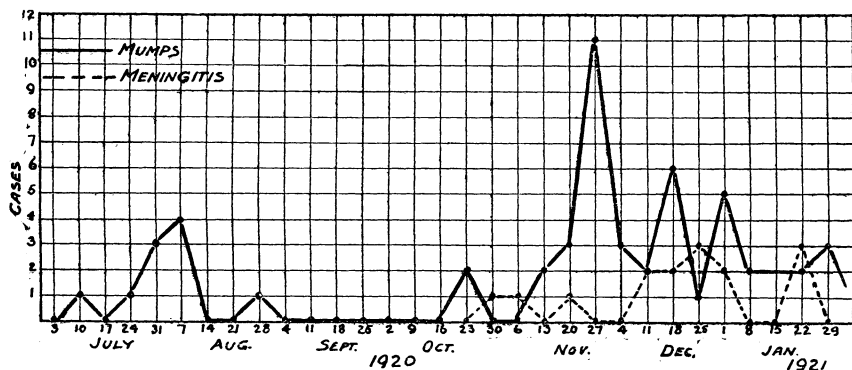


FIG. 3.—Relation of outbreak of mumps to cases of meningitis, by weeks, from July 3, 1920, to January 29, 1921.

The age of the meningitis cases in no instance was above 30 years. The patients were all young adults between the ages of 20 and 30. After the disease was diagnosed, the patients were immediately taken to the isolation hospital in San Francisco for isolation and treatment. The diagnosis was confirmed at this place by an examination of the spinal fluid.

The mortality rate was over 50 per cent, and it is thought that the high rate was due to the fact that the patients did not report themselves sick until they were almost in a state of collapse. Treatment was administered as soon as the diagnosis was made, and consisted of daily spinal injections of a polyvalent meningococcic serum after the necessary amount of spinal fluid had been withdrawn. Intravenous injections of the same serum were given when deemed necessary.

In comparing Table I with Table III, it is of interest to note that different nationalities were affected with this disease in previous years, whereas only Chinese were affected in this epidemic.

In this connection it might be well to mention the unusual occurrence of cases of cerebrospinal meningitis aboard the American steamship *China*. For five successive voyages, not including the last one, one case or more of meningitis has occurred on board ship or upon arrival at the hospital. These cases have occurred only in the male Chinese steerage passengers. The steerage is below decks and the ventilation is very poor at all times. Whether the cases were due to a carrier in the steerage mess crew or due to carriers among fellow passengers it is not possible to state. Only one of the other transpacific liners leaving Hongkong and other Oriental ports has had cases occurring on board ship or soon after arrival at this port. The bills of health show that epidemic cerebrospinal meningitis has been endemic in China for a number of years. A study of the cubic feet of air space and the square feet of floor space per steerage passenger shows that the S. S. *China* does not fall below the other liners in these respects.

Since it was assumed that the outbreak was due to a combination of overcrowding and carriers (before cultures were made), the measures devised to control the epidemic centered about these two factors. The commissioner of immigration was requested not to admit any arriving Chinese males to the Chinese barracks, but to keep them on board the vessel until they were needed for the immigration examination. All rail and water transients were kept on board until transportation was obtained for them to their final destinations. It was suggested that the aliens be broken up into small groups and each group be kept separate from the others; but this was not practicable, as there were no additional accommodations to carry the suggestion into effect. The suggestion was made that visiting and gambling be discouraged, and that every advantage be taken of the sunshine and fresh air. Windows were ordered to be kept open continuously, and expectoration on the floor was prohibited.

When the carrier cases were found they were isolated and kept isolated until two negative release cultures, taken four days apart, were obtained.

It was suggested that when the number of male Chinese being detained reached a figure considerably less than 150 they be placed in smaller quarters in small groups, so that the main detention barracks could be used for other purposes.

The suggestion was also made that in order to prevent future outbreak of disease the floor space and air space for each alien be increased to conform to the standards set by reliable authorities and that the number of aliens detained per barracks be about one-half the present capacity.

To increase the available air space and to permit the aliens to obtain fresh air and exercise it was recommended that clotheslines be installed in the yard for the drying of linens and the airing of bed-

clothes, and that a covered walk be built from the detention barracks to the sheds, this walk being necessary to protect the aliens in rainy and inclement weather when walking to and from the barracks and shed.

EDITORIAL NOTE.—The medical officer in charge of the hospital has reported recently that no case of cerebrospinal meningitis occurred during the month following the institution of remedial measures.

WORLD-WIDE PREVALENCE OF ENCEPHALITIS LETHARGICA.

The following data are taken from the published report of the Session Extraordinaire d'Avril 1920 du Comité Permanent de l'Office International d'Hygiène Publique, Paris, 1920. The information was furnished by the delegates from the different countries, and any hypotheses or conclusions stated here were made by the delegates.

The disease seems to be world wide. Announced in Austria by von Economo at the beginning of 1917, it reached France and England in the spring of 1918, and Italy the following winter. It appeared in Portugal in February, 1919, in India in November, and in Spain in the early part of 1920. It appeared in the United States toward the end of 1918, on the Atlantic coast, and on the Pacific coast in October, 1919. It has also reached Uruguay, South America, and was present in Australia in March, 1919.

Argentina.—Up to May, 1919, no case had been reported in Argentina. The delegate stated that he had no information relative to the disease since that time, but that it was not present during the epidemic of influenza.

Belgium.—In 1919 a small epidemic appeared in three communes of western Flanders, which disappeared during the summer. During the early part of 1920, cases were again reported in about 20 villages scattered throughout the same territory.

Denmark.—From July, 1919, to April, 1920, 58 cases, with 13 deaths, were reported as follows:

Cases by months.

Month.	Male.	Female.	Total.
1919.			
July.....	0	1	1
August.....	1	2	3
September.....	0	0	0
October.....	0	0	0
November.....	3	2	5
December.....	5	4	9
1920.			
January.....	14	6	20
February.....	6	2	8
March.....	5	6	11
April (up to Apr. 10).....	1	0	1
Total.....	35	23	58